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Middle East Water Conflicts and Directions for Conflict Resolution

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Foreword

In looking toward 2020, one of the most severe problems to be faced in many parts of the world is an impending shortage of adequate supplies of fresh water. Clean water for drinking is of course critical for survival, but more effective use of water for crops is also necessary to produce enough food to feed rapidly expanding populations in the coming decades. Issues connected with equitable distribution of dwindling world water supplies could become a major source of both local and international strife unless more is done to assure fair access to water and more efficient water allocation and use.

The Middle East, where a few great waterways are the major source of water for a large area of dry lands spanning a number of national borders, is the place where such strife could erupt first. This 2020 discussion paper by geographer Aaron Wolf not only examines the past—how water in the Middle East came to be divided as it is today—but also looks at possible solutions for alleviating a water crisis and the political tensions it arouses.

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In 1978 the Dead Sea turned over for the first time in centuries. For millennia, this terminal lake at the lowest point on the earth's surface had been receiving the sweet waters of the Jordan River, losing pure water to relentless evaporation, and collecting the salts left behind. The result was an inhospitably briny lake eight times saltier than the sea, topped by a thin layer of the Jordan's less dense fresh water. The two salinity levels of the river and the lake kept the Dead Sea in a perpetually layered state even while the lake level remained fairly constant (evaporation from the lake surface occurs at roughly the rate of the natural flow of the Jordan and other tributaries and springs).

This delicate equilibrium was disrupted as modern nations—with all of their human and economic needs tied to the local supply of fresh water—built along the shores of the Jordan. In this century, as both Jewish and Arab nationalism focused on this historic strip of land, the two peoples became locked in a demographic race for numerical superiority. As more and more of the Jordan was diverted for the needs of these new nations, the lake's level began to drop, most recently by about one-half meter per year (Steinhorn and Gat 1983). As it dropped, more shoreline was exposed, the lake was cut in half by the Lisan Straits, the shallow southern half all but dried up, and the potash works and health spas built to take advantage of the lake's unique waters stood ever farther from the shore.

Along with the drop in lake level came a relative rise in the pycnocline, the dividing line between the less-saline surface water and its hypersaline fossil base. The division between the two layers was finally eradicated briefly in the winter of 1978/79, and the Dead Sea turned over, effectively rolling in its grave—a hydrologic protest against the loss of the Jordan. The turnover brought water to the surface that had not seen the light of day for 300 years (Stiller and Chung 1984). Although it sterilized the lake, this turnover was not counted as an ecological disaster—except for bacteria and one type of alga, the Dead Sea is appropriately named—but the event was a symptom of a wider crisis of history-influencing proportions.

The fact is, the region is running out of water. And the people who have built their lives and livelihoods on a reliable source of fresh water are seeing the shortage of this vital resource impinge on all aspects of the tenuous relations that have developed over the years between nations, between economic sectors, and between individuals and their environment. This water crisis is not limited to the Jordan basin, but extends throughout the Middle East, encompassing also the watersheds of the Nile and the Tigris-Euphrates.

This paper explores how this critical water shortage came about, the political tensions that are intertwined with the scarcity of water, and what the nations of the parched and volatile Middle East can do to help alleviate both the water crisis and the attending political pressures. The following sections describe

- a brief hydropolitical history of the Nile, Jordan, and Tigris-Euphrates basins;
- some technical and policy options for increasing water supply and decreasing water demand;
- an update of the role of water resources in current multilateral peace negotiations;
- a description of the paradigms used to define equity in sharing water resources; and
- a summary of principles for cooperative regional water management.

Background: Hydropolitics of the Middle East

Because of water's preeminent role in survival—from an individual's biology to a nation's economy—political conflicts over international water resources tend to be particularly contentious. The intensity of a water conflict can be exacerbated by a number of factors, including a region's geographic, geopolitic, or hydropolitic landscape. Water conflicts are especially bitter, for example, where the climate is arid, where the riparians of regional waterways are otherwise engaged in political confrontation, or where the population's annual water demand is already approaching or surpassing supply.

The watersheds of the arid and volatile Middle East provide settings for water conflicts of extreme intensity in that each of the three major waterways—the Nile, the Jordan, and the Tigris-Euphrates—have elements of all of these exacerbating factors. In fact, as will be discussed below, scarce water resources have already been at the heart of much of the bitter, occasionally armed, conflict endemic to the region. It is of little wonder that Boutros Boutros-Ghali, currently Secretary-General of the United Nations, in the past suggested that a future war in the Middle East may be fought over water (Starr 1991, 64).

One can find room for optimism, however, in the fact that the same characteristics of water resources that fuel conflict can, if managed carefully, induce cooperation in a hostile environment. According to Frey and Naff (1985, 67), "precisely because it is essential to life and so highly charged, water can—perhaps even tends to—produce cooperation even in the absence of trust between concerned actors."

Living in a transition zone between Mediterranean subtropical and arid climates, the people in and around the major watersheds of the Middle East have always been aware of the limits imposed by scarce water resources. Settlements sprang up in fertile valleys or near large, permanent wells, and trade routes were established from oasis to oasis. In ancient times, cycles of weather patterns had occasionally profound effects on the course of history. For example, recent research suggests that climatic changes 10,000 years ago, which caused the average weather patterns around the Dead Sea to become warmer and drier, may have been an important factor in the birth of agriculture in the region (Hole and McCorriston cited in Stevens 1991).

The fluctuating waters of the ancient Middle East have given rise to legend, extensive water law, and the roots of modern hydrology: the flood experienced by Noah is thought to have centered its devastation around the Babylonian city of Ur, submerging the southern part of the Euphrates for about 150 days, while the code of King Hammurabi contains as many as 300 sections dealing with irrigation. The practice of field surveying was invented to help harness the flooding Nile (El-Yussif 1983). In addition, the waters of the region were occasionally intertwined with military strategy. For instance, in the Bible (Joshua 4), Joshua directed his priests to stem the Jordan's flow with the power of the Ark of the Covenant while he and his army marched across the dry riverbed to attack Jericho.

In the centuries since, the inhabitants of the region and the conquering nations that came and went have lived mostly within the limits of their water resources, using combinations of surface water and well water for survival and livelihood (Beaumont 1991, 1). It was in the beginning of this century, as the competing nationalisms of the region's inhabitants began to re-emerge on the ruins of first the Ottoman then the British empire that the quest for resources took on a new and vital dimension.

The Nile Basin

In the early 1900s, a relative shortage of cotton on the world market put pressure on Egypt and the Sudan, then under a British-Egyptian condominium, to turn to this summer crop, requiring perennial irrigation over the traditional flood-fed methods. The need for summer water and flood control drove an intensive period of water development along the Nile, with proponents of Egyptian and Sudanese interests occasionally clashing within the British foreign office over whether the emphasis for development ought to be further upstream or down.

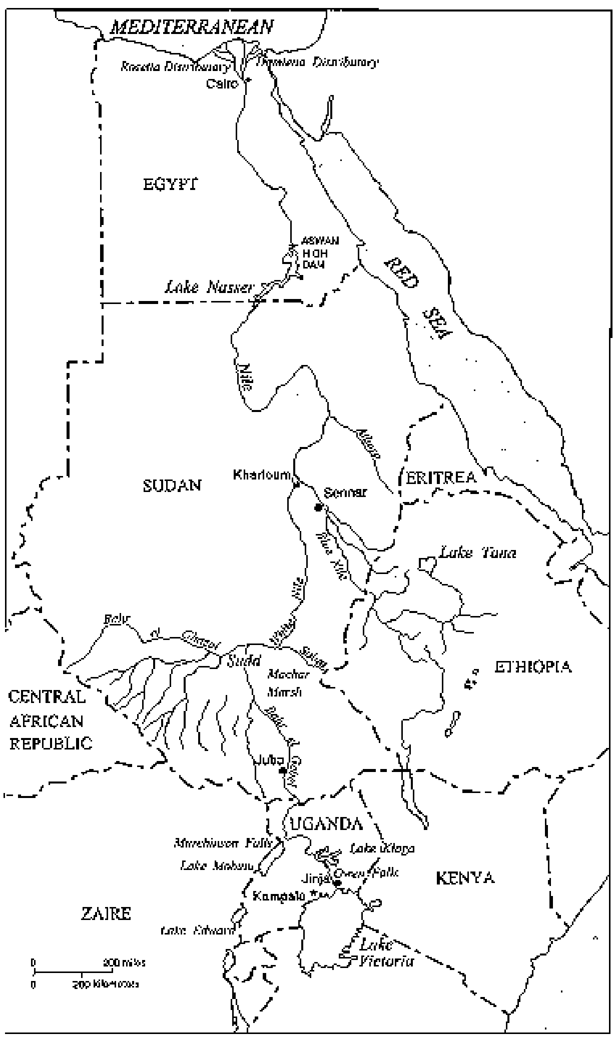
With the end of World War I, it became clear that any regional development plans for the Nile basin would have to be preceded by some sort of formal agreement on water allocations. In 1920, the Nile Projects Commission was formed, with representatives from India, the United Kingdom, and the United States. The Commission estimated that, of the river's average flow of 84 billion cubic meters (BCM) per year, Egyptian needs were 58 BCM per year. Sudan, it was thought, would be able to meet irrigation needs from the Blue Nile alone. Recognizing that the Nile flow fluctuates greatly, with a standard deviation of about 25 percent, the Commission appended its report with the suggestion that any gain or shortfall from the average be divided evenly between Egypt and Sudan. The Commission's findings were not acted upon.

The same year saw publication of the most comprehensive scheme for water development along the Nile (Figure 1). Now known as the Century Storage Scheme, the British plan included

- a storage facility on the Uganda-Sudan border,
- a dam at Sennar, Sudan, to irrigate the Gezira region south of Khartoum, and
- a dam on the White Nile to hold summer flood water for Egypt.

The plan worried some Egyptians and was criticized by nationalists because all the major control structures would have been beyond Egyptian territory and authority. Some Egyptians saw the plan as a British means of controlling Egypt in the event of Egyptian independence.

Figure 1: The Nile Basin



As the Nile riparians gained independence from colonial powers, riparian disputes became international and consequently more contentious, particularly between Egypt and Sudan. The core question of historic versus sovereign water rights is complicated by the technical question of where the river ought best be controlled—upstream or down.

In 1925, a new water commission made recommendations, based on the 1920 estimates, that led to the Nile Waters Agreement between Egypt and Sudan on May 7, 1929. Sudan was allocated 4 BCM per year, but the entire flow from January 20 to July 15 and 48 BCM per year were reserved for Egypt.

The Aswan High Dam, with a projected storage capacity of 156 BCM per year, was proposed in 1952 by the new Egyptian government, but debate over whether the dam was to be built as a unilateral Egyptian project or as a cooperative project with Sudan kept Sudan out of negotiations until 1954. Ensuing negotiations, carried out with Sudan's struggle for independence as a backdrop, focused not only on each country's legitimate allocation, but on whether the dam was the most efficient method of harnessing the waters of the Nile.

The first round of negotiations between Egypt and Sudan took place between September and December 1954, as Sudan was preparing for its independence, scheduled for 1956. The positions of the two sides are summarized in Table 1.

Negotiations broke off inconclusively, then briefly resumed in April 1955. Results were again inconclusive, and relations threatened to deteriorate

Table 1: Water allocations from Nile negotiations

Position	Egypt	Sudan
	(BCM/year)	
Egyptian[a]	62.0	8.0
Sudanese[b]	59.0	15.0
Nile Waters Treaty (1959)[c]	55.5	18.5

Source: Waterbury 1979.

[a]The Egyptian position assumed an average flow of 80 billion cubic meters (BCM) per year and equally divided approximately 10 BCM per year in evaporation losses.

[b]The Sudanese position assumed an average flow of 84 BCM per year and deducted evaporation from the Egyptian allocations.

[c]The Treaty allowed for an average flow of 84 BCM per year and divided evaporation losses equally.

into military confrontation in 1958 when Egypt sent an unsuccessful expedition into territory in dispute between the two countries. In the summer of 1959, Sudan unilaterally raised the Sennar Dam, effectively repudiating the 1929 agreement.

Sudan attained independence on January 1, 1956, but it was under the military regime that gained power in 1958 that Egypt adopted a more conciliatory tone in the negotiations, which resumed in early 1959. Progress was speeded in part because funding for the High Dam depended on a riparian agreement. On November 8, 1959, the Agreement for the Full Utilization of the Nile Waters (Nile Waters Treaty) was signed (Whittington and Haynes 1995; Krishna 1988).

The Nile Waters Treaty had the following provisions:

- The average flow of the river was considered to be 84 BCM per year. Evaporation and seepage were considered to be 10 BCM per year, leaving 74 BCM per year to be divided.
- Of this total, acquired rights had precedence, and were described as being 48 BCM for Egypt and 4 BCM for Sudan. The remaining benefits of approximately 22 BCM were divided by a ratio of 7.5 for Egypt (about 7.5 BCM per year) and 14.5 for Sudan (about 14.5 BCM per year). These allocations totaled 55.5 BCM per year for Egypt and 18.5 BCM per year for Sudan.
- If the average yield increased from these figures, the increase would be divided equally. Significant decreases would be taken up by a technical committee, described below.
- Since Sudan could not absorb that much water at the time, the treaty also provided for a Sudanese water "loan" to Egypt of up to 1.5 BCM per year through 1977.
- Funding for any project that increased Nile flow (after the High Dam) would be provided evenly, and the resulting additional water would be split evenly.
- A Permanent Joint Technical Committee to resolve disputes and jointly review claims by any other riparian would be established. The Committee would also determine allocations in the event of exceptionally low flows.
- Egypt agreed to pay Sudan £E 15 million in compensation for flooding and relocations.

Egypt and Sudan agreed that the combined needs of other riparians would not exceed 1 to 2 BCM per year, and that any claims would be met with one unified Egyptian-Sudanese position. The allocations of the Treaty have been adhered to until the present.

Ethiopia, which had not been a major player in Nile hydropolitics, served notice in 1957 that it would pursue unilateral development of the Nile water resources within its territory, estimated at 75 to 85 percent of the annual flow, and it has been suggested recently that Ethiopia may eventually claim up to 40 BCM per year for its irrigation needs both within and outside the Nile watershed (Jovanovic 1985, 85). No other state riparian to the Nile has ever exercised a legal claim to the waters allocated in the 1959 treaty (Whittington and McClelland 1992).

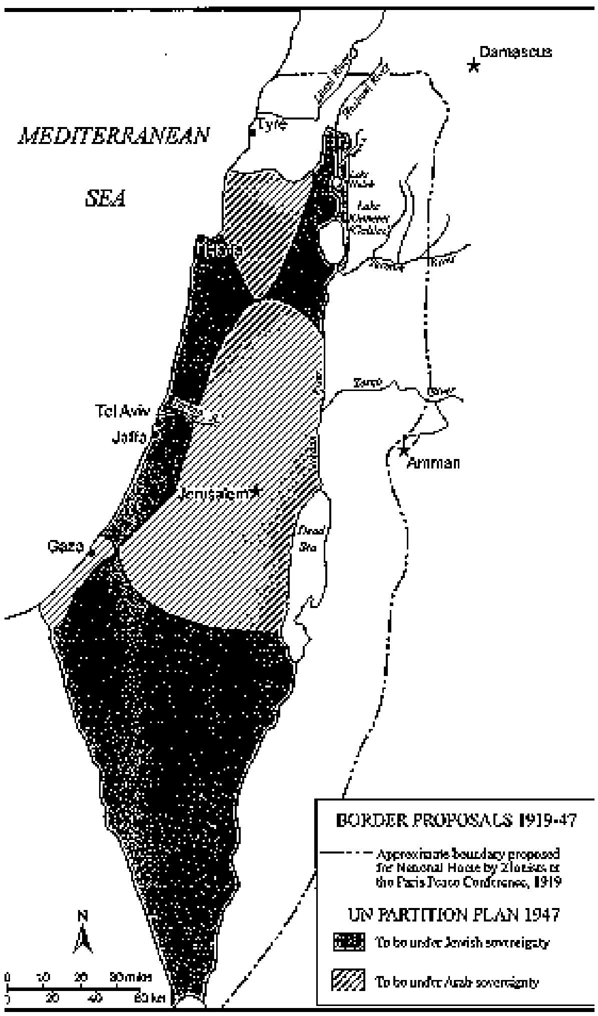
The Jordan Basin

In the years that followed World War I, the location of water resources influenced the boundaries first between the British and French mandate powers that acquired control over the region, then between the states that developed subsequently.[1] The Zionist border formulation for a "national home" presented at the Paris Peace Talks in 1919, for example, was determined by three criteria: historic, strategic, and economic. Economic considerations were defined almost entirely by water resources. The entire Zionist program of immigration and settlement required water for large-scale irrigation and, in a land with no fossil fuels, for hydropower. The development plans and the boundaries required were "completely dependent" on the acquisition of the "headwaters of the Jordan, the Litani River, the snows of Hermon, the Yarmuk and its tributaries, and the Jabbok" (Ra'anan 1955, 87) (Figure 2).

Between the world wars, water became the focus of an even greater political argument over how to develop the budding states around the Jordan watershed, particularly Israel and Jordan, and what the "economic absorptive capacity" would be for immi-

[1] For a more complete account of the Jordan Basin, see Wolf 1995.

Figure 2: Border proposals, 1919 47



gration. Development plans included the Ionides Plan (1939), a British study, which suggested that water would be a limiting factor for any additional immigration to Palestine, and the Lowdermilk Plan (1944), which suggested in contrast that, with proper water management, resources would be generated for 4 million refugees in addition to the 1.8 million Arabs and Jews living in Palestine at the time. British policymakers came down on the side of the Ionides Plan, invoking "economic absorptive capacity" to limit Jewish immigration and land transfers for the duration of World War II.

As the borders of the new states were defined, sometimes by warfare, in the 1950s and 1960s, each country began to develop its own water resources unilaterally. For the Jordan River, the legacy of the mandates and the 1948 war, was a river divided so that conflict over water resource development was inevitable. By the early 1950s, Arab states were discussing organized exploitation of two northern sources of the Jordan, the Hasbani and the Banias (Stevens 1965, 38). The Israelis also made public their All Israel Plan, which included the draining of Huleh Lake and swamps, diversion of the northern Jordan River, and construction of a carrier to the coastal plain and Negev Desert—the first out-of-basin transfer for the watershed (Naff and Matson 1984, 35).

Jordan, in 1951, announced a plan to irrigate the East Ghor of the Jordan Valley by tapping the Yarmuk. At Jordan's announcement, Israel closed the gates of an existing dam south of the Sea of Galilee and began draining the Huleh swamps, which lay within the demilitarized zone with Syria. These actions led to a series of border skirmishes between Israel and Syria, which escalated over the summer of 1951 (Stevens 1965, 39). In July 1953, Israel began construction on the intake of its National Water Carrier at the Daughters of Jacob Bridge north of the Sea of Galilee and in the demilitarized zone. Syria deployed its armed forces along the border and artillery units opened fire on the construction and engineering sites (Cooley 1984, 3, 10). Syria also protested to the United Nations and, though a 1954 resolution for the resumption of work by Israel carried a majority, the Soviet Union vetoed the resolution. The Israelis then moved the intake to its current site at Eshed Kinrot on the northwestern shore of the Sea of Galilee (Garbell 1965, 30).

Against this tense background, U.S. President Dwight Eisenhower sent his special envoy, Eric Johnston, to the Middle East in October 1953 to try to mediate a comprehensive settlement of the Jordan River system allocations. Johnston's initial proposals were based on a study carried out by Charles Main and the Tennessee Valley Authority (TVA) at the request of the United Nations to develop the area's water resources and to provide for refugee resettlement. The proposal, known as the Main Plan, allocated 393 million cubic meters (MCM) per year to Israel, 774 MCM per year to Jordan, and 45 MCM per year to Syria.

Both Israel and a United Arab League technical committee responded with their own counterproposals. The Israeli "Cotton" Plan included integration of the Litani River's flow into the Jordan basin, with a subsequent increase in allocations to Israel. The Arab Plan rejected integration of the Litani and substantially reduced Israel's share, as compared with the Main Plan. Johnston worked until the end of 1955 to reconcile these proposals in a Unified Plan amenable to all of the states involved. In the Unified Plan, Johnston accomplished no small degree of compromise (Table 2). Though they had not met face to face for these negotiations, all states agreed on the need for a regional approach. Israel gave up on integration of the Litani and the Arabs agreed to allow out-of-basin transfer. The Arabs objected but finally agreed to storage at both the Maqarin Dam and the Sea of Galilee so long as neither side would have physical control over the share available to the other. Israel objected but finally agreed to international supervision of withdrawals and construction. Allocations under the Unified Plan, later known as the Johnston Plan, included 400 MCM per year to Israel, 720 MCM per year to Jordan, 35 MCM per year to Lebanon, and 132 MCM per year to Syria (U.S. Department of State 1955, 1956).

The technical committees from both sides accepted the Unified Plan but momentum died in the political realm, and the Plan was never ratified. Nevertheless, Israel and Jordan have generally adhered to the Johnston allocations and technical representatives from both countries have met from that time until the present two or three times a year to discuss flow rates and allocations at "Picnic Table Talks," named for the site at the confluence of the Yarmuk and Jordan Rivers where the meetings are held.

Table 2: Water allocations from Johnston negotiations

Plan	Israel	Jordan	Lebanon	Syria
	(MCM/year)			
Main	393	774	0	45
Cotton (Israeli)[a]	1,290	575	450	30
Arab	182	698	35	132
Unified	400[b]	720[c]	35	132

Source: Naff and Matson 1984.

[a]The Cotton Plan included integration of the Litani River into the Jordan Basin.

[b]The Unified Plan allocated Israel the "residue" flow, what remained after the Arab States withdrew their allocations, estimated at an average 409 million cubic meters (MCM) per year.

[c]Two different summaries were distributed after the negotiations, with a difference of 15 MCM per year on allocations between Israel and Jordan on the Yarmuk River. This difference was never resolved, and was the focus of Yarmuk negotiations in the late 1980s.

As each state developed its water resources unilaterally, their plans began to overlap. By 1964, for instance, Israel had completed enough of its National Water Carrier system (designed to carry water from the headwaters in the north to the Israeli population along the Mediterranean coast, that actual diversions from the Jordan River basin to the coastal plain and the Negev were imminent. Although Jordan was also about to begin extracting Yarmuk water for its East Ghor Canal, it was the Israeli diversion that prompted Egyptian President Nasser to call for the First Arab Summit in January 1964, including heads of state from the region and North Africa, specifically to discuss a joint strategy on water.

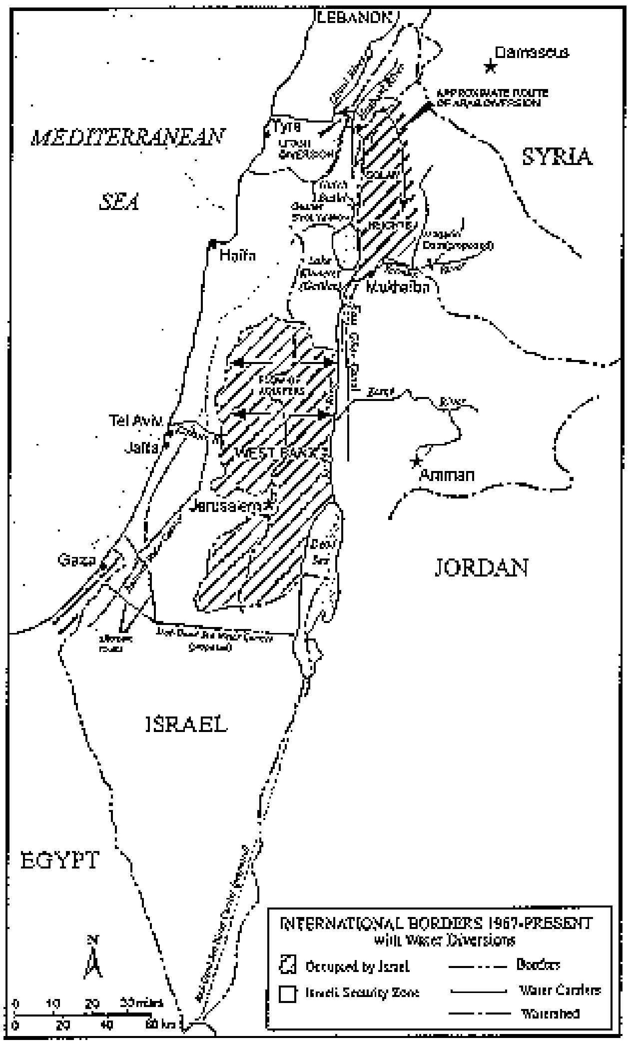
The options presented at the Summit were to complain to the United Nations; divert the upper Jordan tributaries into Arab states, as had been discussed by Syria and Jordan since 1953; or to go to war (Schmida 1983, 19). The decision to divert the rivers prevailed at a second summit in September 1964, and the Arab states agreed to finance a Headwater Diversion project in Lebanon and Syria and to help Jordan build a dam on the Yarmuk. They also made tentative military plans to defend the diversion project (Shemesh 1988, 38).

In 1964, Israel began withdrawing 320 MCM per year of Jordan water for its National Water Carrier and Jordan completed a major phase of its East Ghor Canal (Inbar and Maos 1984b, 21). In 1965, the Arab states began constructing their Headwater Diversion Plan to prevent the Jordan headwaters from reaching Israel. The plan was to divert the Hasbani into the Litani in Lebanon and the Banias into the Yarmuk where it would be impounded for Jordan and Syria by a dam at Mukheiba. The plan would divert up to 125 MCM per year, cut by 35 percent the installed capacity of the Israeli carrier, and increase the salinity in the Sea of Galilee by 60 parts per million (U.S. Central Intelligence Agency 1962; Inbar and Maos 1984a; Naff and Matson 1984). In March, May, and August 1965, the Israeli army attacked the diversion works in Syria.

These events set off what has been called "a prolonged chain reaction of border violence that linked directly to the events that led to the (June 1967) war" (Cooley 1984, 16). Border incidents continued between Israel and Syria, triggering air battles in July 1966 and April 1967, and culminating in all-out war in June 1967.

By gaining territory and improving its geostrategic position, Israel also improved its "hy-

Figure 3: International borders, 1967-present



drostrategic" position (Figure 3). With the Golan Heights, Israel now held all of the headwaters of the Jordan, with the exception of a section of the Hasbani, and an overlook over much of the Yarmuk, together making the Headwaters Diversion Plan impossible. The West Bank not only provided riparian access to the entire length of the Jordan River, but it overlay three major aquifers, two of which Israel had been tapping into from its side of the Green Line since 1955 (Garbell 1965, 30). Jordan had planned to transport 70–150 MCM per year from the Yarmuk River to the West Bank. These plans, too, were abandoned.

In the years since, increased integration of the West Bank and Gaza into the economic and hydrologic networks of Israel has led to increasing hydropolitical tensions. As mentioned above, when Israel took control of the West Bank and Gaza in 1967, the territory captured included the recharge areas for aquifers that follow west and northwest from the West Bank into Israel, and east to the Jordan Valley (Kahan 1987, 21). The entire renewable recharge of these first two aquifers is already being exploited and the recharge of the third is nearly depleted.

In the years of Israeli occupation, a growing West Bank and Gaza population, along with burgeoning Jewish settlements, has increased the burden on the limited groundwater supply, exacerbating already tense political relations. Palestinians have objected strenuously to Israeli control of local water resources and to settlement development, which they see as being at their territorial and hydrologic expense.[2] Israeli authorities view hydrologic control in the West Bank as defensive. With about 30 percent of Israeli water originating on the West Bank, the Israelis perceive the necessity to limit groundwater exploitation in these territories in order to protect the resources themselves and their own wells from saltwater intrusion (Gruen 1991).

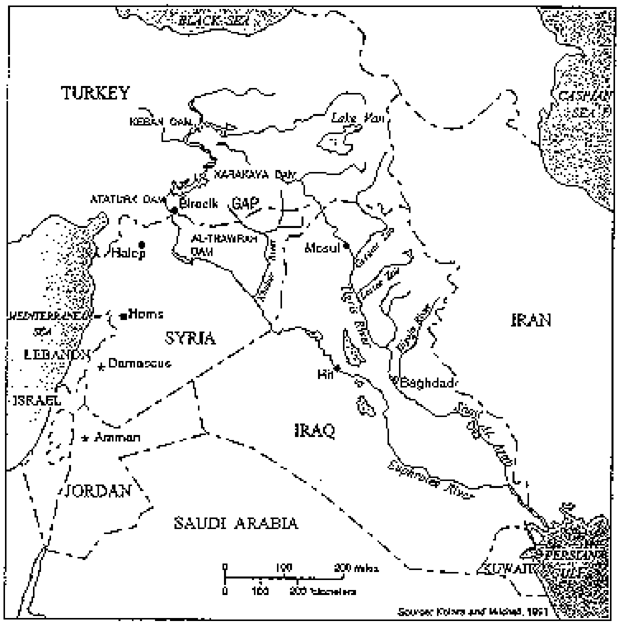
The Tigris-Euphrates Basin

Hydropolitical tensions have not been limited to the Nile and the Jordan basins. In 1975, unilateral water developments almost led to warfare along the Euphrates. The three riparians to the river—Turkey, Syria, and Iraq— had been coexisting with varying degrees of hydropolitical tension through the 1960s. At that time, population pressures drove unilateral developments, particularly in southern Anatolia with the Keban Dam (1965–73) and in Syria with the Tabqa Dam (1968–73) (Lowi 1993, 108) (Figure 4).

Bilateral and tripartite meetings, occasionally with Soviet involvement, had been carried out among the three riparians since the mid-1960s, although no formal agreements had been reached by the time the Keban and Tabqa dams began to fill in late 1973, resulting in decreased flow downstream.

[2]See, for example, Davis, Maks, and Richardson 1980; Dillman 1989; and Zarour and Isaac 1993.

Figure 4: The Tigris-Euphrates Basin



Source: Based on Kolars and Mitchell 1991.

In mid-1974, at Iraq's request, Syria agreed to allow an additional flow of 200 MCM per year from Tabqa. The following year, however, the Iraqis claimed that the flow had dropped from the normal 920 cubic meters per second to an "intolerable" 197 cubic meters per second and asked that the Arab League intervene. The Syrians claimed that less than half the river's normal flow had reached their borders that year and, after a barrage of mutually hostile statements, pulled out of an Arab League technical committee formed to mediate the conflict. In May 1975, Syria closed its airspace to Iraqi flights, and both Syria and Iraq reportedly transferred troops to their mutual border. Only Saudi Arabia's mediation was able to break the increasing tension, and on June 3, the parties arrived at an agreement that averted the impending violence. Although the terms were not made public, Naff and Matson (1984, 94) cite Iraqi sources as privately stating that the agreement called for Syria to keep 40 percent of the flow of the Euphrates within its borders, and to allow the remaining 60 percent through to Iraq.

The Turkish GAP project has given a sense of urgency to resolving allocation issues concerning the Euphrates. The Southeast Anatolia Development Project (GAP is the Turkish acronym) is a massive undertaking for energy and agricultural development, which, when completed, will include the construction of 21 dams and 19 hydroelectric plants on both the Tigris and the Euphrates rivers. According to the plan, 1.65 million hectares of land will be irrigated and 26 billion kilowatt-hours will be generated annually, with an installed capacity of 7,500 megawatts.

A 1987 visit to Damascus by Turkish Prime Minister Turgut Ozal reportedly resulted in a signed agreement for the Turks to guarantee a minimum flow of 500 cubic meters per second across the border with Syria. According to Kolars and Mitchell (1991), this total of 16 BCM per year is in accordance with prior Syrian requests. However, according to Naff and Matson (1984), this is also the amount that Iraq insisted on in 1967, leaving a potential shortfall. A tripartite meeting of Turkish, Syrian, and Iraqi ministers was held in November 1986, but yielded few results (Kolars and Mitchell 1991).

Talks between the three countries were held again in January 1990, when Turkey closed the gates to the reservoir on the Ataturk Dam, the largest of the GAP dams, essentially shutting off the flow of the Euphrates for 30 days. At this meeting, Iraq again insisted that a flow of 500 cubic meters per second cross the Syrian-Iraqi border. The Turkish representatives responded that this was a technical rather than political issue and the meetings stalled. The Gulf War, which broke out later that month, precluded additional negotiations (Kalors and Mitchell 1991).

In their first meeting after the war, Turkish, Syrian, and Iraqi water officials convened in Damascus in September 1992, but broke up after Turkey rejected an Iraqi request that flow crossing the Turkish border be increased from 500 cubic meters per second to 700 cubic meters per second (Gruen 1993). In bilateral talks in January 1993, however, Turkish Prime Minister Demirel and Syrian President Assad discussed a range of issues intended to improve relations between the two countries. Regarding the water conflict, the two agreed to resolve the issue of allocations by the end of 1993. Although this has not been done to date, Prime Minister Demirel declared at a press conference closing the summit that "there is no need for Syria to be anxious about the water issue. The waters of the Euphrates will flow to that country whether there is an agreement or not" (Gruen 1993).

The waters of the Middle East have been the focus both of bitter conflict over a scarce and vital resource and of cooperation between otherwise hostile neighbors. From the Nile to the Jordan to the Tigris-Euphrates, armies have been mobilized and treaties signed over this precious commodity. In recent years, the needs of ever-increasing populations and burgeoning national development have begun to approach and sometimes exceed local hydrologic limits. As shortages become more acute, unilateral plans increasingly impose on riparians, physically driving home the potential hazards of resource conflict and the benefits of regional cooperation.

Along these international waterways, two issues are intertwined. The first is a water crisis. A problem found in water basins around the world, this aspect might simply be described as too little water for too many people. The aim of all possible approaches, whether technical or policy oriented, is to make the basin's water supply meet the demand. The other issue might be referred to as a water conflict. This site-specific aspect describes the political tensions attending a lack of water in a particular basin. In the following sections, both aspects of the waters of the Middle East are addressed. Some technical and policy options that may help ameliorate the water crisis are described below.

Table 3: Water management options to increase supply or decrease demand

Unilateral options

Decrease demand

- Population control
- Rationing
- Public awareness
- Allow price of water to reflect true costs (including national water markets)
- Efficient agriculture, including:
  - Drip irrigation
  - Greenhouse technology
  - Genetic engineering for drought and salinity resistance

Increase supply

- Wastewater reclamation
- Increase catchment and storage (including artificial groundwater recharge)
- Cloud seeding
- Desalination
- Fossil aquifer development

Cooperative options

- Shared information and technology
- International water markets to increase distributive efficiency
- Interbasin water transfers
- Joint regional planning

Technical and Policy Options

There is an array of solutions to water resource limits ranging from agricultural to technological to economic and public policy, but, as for any resource shortage, they all fall under two basic categories: increase supply or decrease demand (Table 3). Allowances must also be made for anticipated shifts in climate and demographics.

Increasing Supply

New natural sources. No new "rivers" will be discovered in the Middle East, but increased catchment of winter floodwater anywhere along the existing river system can also add to the water budget. This applies to small wadis as well as to large storage projects. When it is possible to store water underground through artificial groundwater recharge, even more water is saved—that not lost to evaporation in a surface reservoir. Less evaporation also means less of a salinity problem in the remaining water.

Underground is the only place to look for any real new water supplies. In 1985, Israel confirmed the discovery of a large fossil aquifer in the Nubian sandstone underlying the Sinai and Negev deserts. Israel is already exploiting 25 MCM per year from this source and is investigating the possibility of pumping 300 MCM per year in the coming century (Issar 1985, 104, 110). Jordan has also been carrying out a systematic groundwater evaluation project (Starr and Stoll 1988, 32).

Any other source would come at the expense of another watershed. Despite this, at one time or another, Israel has eyed the Litani and the Nile, Jordan has looked to the Euphrates, and all of the countries in the area have been intrigued by the "peace pipeline" proposed by Turkey in 1987. The western line of this project would deliver 1.2 BCM per year from the Seyhan and Ceyhan rivers to Syria, Jordan, and Saudi Arabia (Duna 1988, 119). Despite Turkish Prime Minister Ozal's belief that, "by pooling regional resources, the political tensions in the area can be diffused," at a cost of $20 billion, the idea did not rapidly gain popularity (Duna 1988, 121). With the recent passing of Prime Minister Ozal, enthusiasm for the plan seems to have passed on as well.

New sources through technology. Projects like iceberg towing and cloud seeding, though appealing to the imagination, do not seem to be the most likely direction for future technology. The former involves great expense and the latter can be, at best, a small part of a local solution. Although a representative of Israel's water authority claims that 15 percent of Israeli annual rainfall is due to their cloud-seeding program, this has been documented only within the northern Galilee catchment and results seem not to have the consistency necessary for reliable planning (Siegal 1989, 12).

The two most likely technologies to increase water supply are desalination and wastewater reclamation. The Middle East has already spent more on desalting plants than any other part of the world. The region has 35 percent of the world's plants with 65 percent of the total desalting capacity, mostly along the Arabian peninsula (Anderson 1988, 4).

High costs make desalinated water expensive for most applications. Although drinking water is a completely inelastic good—that is, people will pay almost any price for it—water for agriculture, by far the largest use in the Middle East, has to be cost-effective enough so that the agricultural end-product remains competitive in the marketplace. The present costs of about \$0.80 to \$1.50 per cubic meter to desalt seawater and about \$0.30 per cubic meter to treat brackish water do not make this technology an economic water source for most uses (Awerbuch 1988, 59). Efforts are being made, however, to lower these costs through multiple-use plants (getting desalted water as a byproduct in a plant designed primarily for energy generation), through increased energy efficiency in plant design, and by augmenting conventional plant power with solar or other energy sources.[3]

One additional use of salt water is to mix it with fresh water in just the quantity to leave it useful for agricultural or industrial purposes, effectively adding to the freshwater supply. This method was used in the 1975/76 season to add 141 MCM per year to the water budget of the Jordan basin (Kahhaleh 1981).

The other promising technology to increase supply is wastewater reclamation. Two plants in Israel currently treat 110 MCM per year or 40 percent of the country's sewage for re-use, and projections call for treating 80 percent by the end of the decade (Israel, Environmental Protection Service 1988, 147). The treated water is currently used to irrigate some 15,000 hectares—mostly cotton. It is anticipated that full exploitation of purified wastewater will eventually constitute 45 percent of domestic water needs. This type of project could be developed throughout the region. The obvious limit of this technology is the amount of wastewater generated by a population in a year.

Decreasing Demand

The guiding principle to decrease demand for any scarce resource should be, "Can it be used more efficiently?" This does not always work, however, especially when there is an emotional value associated either with the resource itself or with the proposed solution. Unfortunately, when dealing with water, emotions usually charge both aspects of the issue. For example, the most direct way to cut demand for Middle East water is to limit population growth in the region. However, in an area where national groups and religious and ethnic subgroups all seem to be locked in some demographic race for numerical superiority, this is not likely to occur. Many of the sectors most susceptible to efficient restructuring are also those most laden with emotion.

Agriculture sector. Some aspects of decreasing agricultural water demand are noncontroversial and have made the region a showcase for arid-agriculture water conservation. Technological advances like drip-irrigation and micro-sprinklers, which reduce water loss by evaporation, are about 20 to 50 percent more efficient than standard sprinklers and tremendously more so than the open-ditch flood method used in the region for centuries (Israel, Environmental Protection Service 1988, 144). Computerized control systems, working in conjunction with direct soil moisture measurements, can add even more precision to crop irrigation.

Other water savings have come through bioengineered crops that exist on a minimal amount of fresh water, on brackish water, or even on the direct application of salt water.[4]

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[3] For information on nonconventional desalination projects, see Murakami 1995.

[4] For interesting examples of direct seawater irrigation, see Hodges, Collins, and Riley 1988, 109–118.

Using a combination of these conservation methods, Israel's irrigated area increased from 172,000 hectares in 1973 to 220,000 hectares in 1988, with total production increasing by 100 percent, while water consumption for agriculture remained nearly constant (Israel, Environmental Protection Service 1988, 144). Observers have speculated that the irrigated area on the West Bank could likewise be doubled without increasing the demand for water (Heller 1983, 130). Meanwhile, these techniques have been spreading throughout the region, and it is reasonable to assume that increased water efficiency will continue to be an important aspect of Middle East agriculture.

Emotional charge enters into the water debate only when economists or planners suggest that greater hydrologic efficiency might be gained if less water were used in agriculture.

Economic water efficiency. Water distribution in the Middle East is so riddled with economic inefficiency that an economist approaching it must feel very much like a designer of drip irrigation watching a field being flood-irrigated. The main problem is that the cost of water to the user is highly subsidized, especially water earmarked for agriculture. The true cost of water would reflect all of the pumping, treatment, and delivery costs, most of which are not passed on to the farmers.

Economic theory argues that only when the price paid for a commodity reasonably reflects the true price can market forces work for efficient distribution.[5] In other words, subsidized water leads to waste in agricultural practices, little incentive for research and development of conservation techniques and practice, and too much water allocated to the agriculture sector as opposed to industry. Remove subsidies and allow the price to rise, it is argued, and market incentives are created for both greater efficiency on the farm and a natural shift of water resources from the agriculture sector to industry, where contribution to GNP per unit of water is often much higher (Wishart 1989, 49). Since, in each of the areas discussed, between 75 and 95 percent of water use is allocated for agriculture, the savings could be substantial.

Economic analysis may also create a framework for easing regional water tensions. "Put simply, conflicts over water rights are easier to resolve if transaction costs of resolution are lower, and if opportunities exist for improving the efficiency of water use and discovery," according to Wishart (1989, 50). If it is cheaper for people to cooperate and save water than to fight, they would rather cooperate.

There are, however, problems inherent in using economic theory as the tool for water conflict analysis—problems that can lead to weaknesses in the economic solutions prescribed. First, water is not a pure economic good. Options to consumers of most goods include migrating to where the item is cheaper or abstaining from it altogether if the price is too high. Given small countries with tightly controlled borders, the former is not a viable alternative for water consumers, nor, for more obvious biological reasons, is the latter. Presumably, though, the analysis is restricted to water for agriculture where there is ample room for reducing demand before running into such dangers.

The second problem is more serious because it has to do with a force much more fundamental than economic theory—the emotions of a nation. All of the countries in the area were built from the farm up and the agriculturalist, whether the *fellah* or the *kibbutznik*, holds a special mystique along the banks of all of the region's rivers. Arabic, Hebrew, and Turkish ideologies are rife with slogans of "making the desert bloom" and "nations rooted in their land." In this context, water invariably becomes the lifeblood of a nation. One result of this has been a certain leeway, both political and financial, granted to agriculture.

Overlooking this fundamental aspect of a national water ethic can confound an economist, especially one from outside of the region. Even while recognizing its limits, though, one can still use economic analysis to provide guidelines to increase hydrological efficiency. And following these guidelines can be crucial, particularly as water limits begin to be reached. As Galnoor (1978, 360) has pointed out:

> Whereas diseconomies dictated by ideology could be tolerated under conditions of conventional water sufficiency, they cannot continue indefinitely, especially with regard

[5]For an economic analysis of Jordan River water, see Wishart 1989, 45–53.

to investments under conditions of a system's shortage.

Public policy. Where the "invisible hand" of economic forces fails to guide a more efficient water use, the more authoritative guidelines of public policy can take over. Government agencies could simply implement one analyst's prescription of cutting water to agriculture by 35 percent, if they wished (Naff 1990). The "if they wished" is the problem. The same national water ethics that give agriculture great economic clout in the region also give it great political clout. The Water Commission in Israel, for example, is the ultimate authority for all water planning and operations in the country. It, in turn, is controlled by the Ministry of Agriculture. Clearly there is room for improvement even in national public policy. But the real opportunities come from the international policy sector.

Water policy in this region is presently drawn up within the boundaries of a nation, rather than a watershed. Because the flow of water does not respect political boundaries, it should be clear that regional management, at the watershed level at least, would be a much more efficient approach. In fact, the only point on which the water policy analyses surveyed here agree is on the need for planned water sharing and joint water development, as Eisenhower's envoy Eric Johnston envisioned 35 years ago.

Regional cooperation would open the door to a host of new water distribution alternatives.[6] For example, surface water from the Yarmuk or the upper Jordan could be provided to the West Bank, allowing increased development in that area while alleviating Israeli fears of overdrafted Palestinian wells. Or, Israel and Jordan might cooperatively develop both banks of the Jordan, eliminating the current redundant costs of separate delivery systems within each country. The larger the region cooperating, the more efficient the regional plan that can be developed. It is cheaper, for example, to bring water from the Nile to the Negev than it is to pump it from the Sea of Galilee, the current practice (Kally 1989b, 305).

A word of caution: despite one author's contention (Kally 1989a, 325) that "the successful implementation of cooperative projects . . . will strengthen and stabilize peace," this does not necessarily seem to be the case. It seems at this point inconclusive whether greater interdependence is actually an impetus to greater cooperation or greater conflict. Many of the hostilities over water that have occurred in the region seem to have come about precisely because the water destined for a downstream user was controlled by an upstream party. Many "cooperative" projects might only provide additional opportunity for suspicion and potential for contention. Lowi (1993) suggests that issues of regional water-sharing cannot be successfully broached until the larger political issues of territory and refugees are resolved.

However, the concept should not be abandoned because projects would have to be weighed in terms of the conflict-alleviating tendencies of more efficient water distribution as opposed to the possible conflict-heightening of greater hydrologic interdependence. Nor should the concept of a regional planning approach be tarnished because of uncertainty about specific projects.

Even were the riparians of the rivers of the Middle East to agree to implement many or all of the above steps in a rational fashion, only the regional water crisis, that is, the lack of water in the basin for anticipated needs, would be addressed.[7] The water conflict—the political tensions attendant to the lack of water—would remain. Fortunately, recent hydropolitical events have allowed for a forum for airing issues of water scarcity and water politics. Eventually, perhaps, these issues will be resolved.

By 1991, several events had combined to shift the emphasis on the potential for "hydro-conflict" in the Middle East to the potential for "hydro-cooperation." The first event was natural, but limited to the Jordan basin. Three years of below-average rainfall dramatically tightened the water management practices of each of the riparians, including rationing, cutbacks to agriculture by as much as 30 percent, and restructuring of water pricing and allocations. Although these steps imposed short-term hardships,

[6]Many cooperative water projects are described in detail in Kally 1989b (in Hebrew).

[7]Much work has been done to try to prioritize these steps for regional development, mostly for the Jordan basin. See, for example, Wolf and Murakami 1995.

they also showed that, for years of normal rainfall, there was still some flexibility in the system. Most water decisionmakers agree that these steps, particularly regarding pricing and allocations to agriculture, were long overdue.

The next series of events were geopolitical and regionwide. The Gulf War in 1990 and the collapse of the Soviet Union realigned political alliances in the Middle East and finally made possible the first public face-to-face peace talks between Arabs and Israelis, in Madrid on October 30, 1991. During the bilateral negotiations between Israel and each of its neighbors, it was agreed that a second track be established for multilateral negotiations on five regional subjects, including water resources.

Water and the Peace Process

The First Four Meetings of the Working Group

Since the opening session of the multilateral talks in Moscow in January 1992, the Working Group on Water Resources, with the United States as "gavel holder," has been the venue by which problems of water supply, demand, and institutions are raised among three of the five parties to the bilateral negotiations. Israel, Jordan, and the Palestinians participate in the Working Group; Lebanon and Syria do not. Many Arab states from the Gulf and the Maghreb also participate, as do nonregional delegations, including representatives from governments and donor organizations.[8]

The bilateral and multilateral tracks of the negotiations are designed not only to close the gap between issues of politics and regional development, but perhaps to use progress on each to help catalyze the pace of the other, toward a just and lasting peace in the Middle East. The multilateral working groups provide forums for relatively free dialogue on the future of the region and, in the process, allow for personal icebreaking and confidence building, helping to smooth the way for progress in the bilateral talks. Additionally, while political considerations are clearly important factors in the multilateral talks, innovative, creative ideas can be exchanged and discussed more openly outside the heavy political constraints of the more formal bilateral negotiations.

The objectives thus far have been more in the nature of fact-finding and workshops, rather than tackling the difficult hydropolitical issues of water rights and allocations or developing specific projects. Decisions are made through consensus only. The Working Group on Water Resources has met five times (rounds 2 through 6), as illustrated in Table 4.

The pace of success has varied but, in general, has been increasing. The second round, the first meeting of the water group alone, has been characterized as "contentious," with initial posturing and venting on all sides.[9] Palestinians and Jordanians, then part of a joint delegation, first raised the issue of water rights, claiming that no progress can be made on any other issue until past grievances are addressed. In sharp contrast, the Israeli position has been that water rights is a bilateral issue, and that the multilateral water working group should focus on joint management and development of new re-

Table 4: Meetings of the Multilateral Working Group on Water Resources

Meeting	Dates	Location
Multilateral organizational meeting	January 28–29, 1992	Moscow
Water talks, round 2	May 14–15, 1992	Vienna
Water talks, round 3	September 16–17, 1992	Washington, D.C.
Water talks, round 4	April 27–29, 1993	Geneva
Water talks, round 5	October 26–28, 1993	Beijing
Water talks, round 6	April 17–19, 1994	Muscat

[8] The complete list of parties invited to each round includes representatives from Algeria, Australia, Austria, Bahrain, Belgium, Canada, China, Denmark, Egypt, European Union, Finland, France, Germany, Greece, India, Ireland, Israel, Italy, Japan, Jordan, Kuwait, Luxembourg, Mauritania, Morocco, the Netherlands, Norway, Oman, the Palestinians, Portugal, Qatar, Russia, Saudi Arabia, Spain, Sweden, Switzerland, Tunisia, Turkey, Ukraine, United Arab Emirates, United Kingdom, United Nations, United States, the World Bank, and Yemen.

[9] After some confusion in numbering, it was officially decided that the multilateral organizational meeting in Moscow represented the first round of the multilateral working groups. Subsequent meetings are therefore numbered correspondingly, beginning with round 2.

sources. Since decisions are by consensus, little progress was made on either issue. Nevertheless, plans were made to continue the talks—an achievement in itself.

The third round, in Washington, D. C., in September 1992, made somewhat more progress. Consensus was reached on a general emphasis for future talks that the U.S. State Department had proposed in May, focusing on four subjects:

- enhancement of water data,
- water management practices,
- enhancement of water supply, and
- concepts for regional cooperation and management.

Progress was also made on the definition of the relationship between the multilateral and bilateral tracks. By this third meeting, it became clear that regional water-sharing agreements, or any political agreements surrounding water resources, would not be dealt with in the multilaterals, but that the role of these talks was to address nonpolitical issues of mutual concern, thereby strengthening the bilateral track. The goal in the Working Group on Water Resources became to plan for a future region at peace, and to leave the pace of implementation to the bilaterals. This distinction between planning and implementation has become crucial, with progress only being made as the boundary between the two is continuously pushed and blurred by the mediators.

The fourth round, in Geneva in April 1993, proved particularly contentious, threatening at points to halt the process. Initially, the meeting was to be somewhat innocuous. A series of intersessional activities surrounding the four subjects agreed to at the previous meeting was proposed. These activities, including study tours and water-related courses, would help capacity-building while fostering better personal and professional relations.

The issue of water rights was raised again, however, with the Palestinians threatening to boycott the intersessional activities. The Jordanians, who had already agreed to discuss water rights with the Israelis, helped work out a similar arrangement on behalf of the Palestinians, and both sides agreed to the terms after quiet negotiations in May, before the meeting in Oslo of the working group on refugees. The agreement called for three Israeli-Palestinian working groups within the bilateral negotiations, one of which would deal with water rights. The agreement, in which the Palestinians consented to participate in the intersessional activities, also called for U.S. representatives of the water working group to visit the region. While some may have expected the U.S. representatives to use the opportunity to take a strong proactive position on the issue of water rights, the delegates held that any specific initiatives have to come from the parties themselves, and that agreement must be by consensus.

By July 1993, the intersessional activities had begun, with about 20 activities as diverse as a study tour of the Colorado River basin and a series of seminars on semi-arid lands. Recent emphasis has been on capacity-building in the region. A series of 14 courses has recently been designed with and for participants from the region by the United States and the European Union, to range in length from 2 weeks to 12 months, and to cover subjects as broad as concepts of integrated water management and as detailed as groundwater flow modeling. The donor community pledged to fund these courses.

The Israeli-Palestinian Declaration of Principles

On September 15, 1993, the Declaration of Principles on Interim Self-Government Arrangements, which called for Palestinian autonomy in and the removal of Israeli military forces from Gaza and Jericho, was signed between Palestinians and Israelis. Among other issues, this bilateral agreement called for the creation of a Palestinian Water Administration Authority. Moreover, the first item in Annex III, on cooperation in economic and development programs, included a focus on

> cooperation in the field of water, including a Water Development Program prepared by experts from both sides, which will also specify the mode of cooperation in the management of water resources in the West Bank and Gaza Strip, and will include proposals for studies and plans on water rights of each party, as well as on the equitable utilization of joint water resources for implementation in and beyond the interim period.

Although the declaration was generally seen as a positive development by most parties, the Jordanians raised concerns about the Israeli-Palestinian agreement to investigate a possible Med-Dead Canal—a project to link the Mediterranean and Dead Seas, taking advantage of the 400-meter drop in elevation to generate hydropower. In the working group on regional economic development, the Italians had pledged $2.5 million toward a study of a Red-Dead Canal, a similar project using the same elevation difference between the Red and Dead Seas, as a joint Israeli-Jordanian project; building both would be infeasible. The Israelis pointed out in private conversations with the Jordanians that all possible projects should be investigated, and only then could rational decisions on implementation be made.

Although it is a bilateral agreement, the Declaration of Principles helped streamline logistically awkward aspects of the multilaterals, as the PLO became openly responsible for the talks and the Palestinian delegation separated from the Jordanians.

The Fifth and Sixth Meetings

By the fifth round of water talks in Beijing in October 1993, a routine seemed to be setting in. Reports were presented on each of the four topics agreed to at the second meeting in Vienna—increasing data availability, enhancing water supply, water management and conservation, and regional cooperation and management—and a new series of intersessional activities was announced.

The sixth and most recent round of water talks was held in Muscat, Oman, in April 1994, the first to be held in an Arab country and the first meeting of any working group to be held in the Gulf. Tensions mounted immediately before the talks as it became clear that the Palestinians would use the occasion as a platform to announce the appointment of a Palestinian National Water Authority. While such an authority was called for in the Declaration of Principles, possible responses to both the unilateral nature of the announcement and the appropriateness of the water working group as the vehicle for the announcement were unclear. Only a flurry of activity prior to the talks guaranteed that the announcement would be welcomed by all parties. This agreement set the stage for a particularly productive meeting. In two days, the working group endorsed

- an Omani proposal to establish a Muscat desalination research and technology center that would support regional cooperation among all interested parties (this marked the first Arab proposal to reach consensus in the working group);
- an Israeli proposal to rehabilitate and improve water systems in small communities in the region (this was the first Israeli proposal to be accepted by any working group);
- a German proposal to study the water supply and demand development among interested core parties in the region;
- a U.S. proposal to develop wastewater treatment and re-use facilities for small communities at several sites in the region (the proposal was jointly sponsored by the water and environmental working groups); and
- implementation of the U.S./EU regional training program, as described earlier.

As mentioned above, the working group officially welcomed the announcement of the creation of the Palestinian Water Authority, and pledged to work with the Authority on multilateral water issues.

The Israel-Jordan Treaty of Peace

Recent progress has been notable in bilateral negotiations between Jordan and Israel. On June 7, 1994, the two states announced an agreement on a subagenda for cooperation, building on an agenda for peace talks agreed to September 14, 1993, which would lead eventually to a peace treaty. This subagenda included several water-related items, notably in the first heading listed, ahead of security issues and border and territorial matters.

These principles were formalized on October 26, 1994, when Israel and Jordan signed a peace treaty, ending more than four decades of a legal, when not actual, state of war. The peace treaty was only signed after resolving the last and most contentious issue—shared water resources.

For the first time since the states came into being, the treaty legally spells out mutually recognized water allocations. Acknowledging that “water issues along their entire boundary must be dealt with in their totality,” the treaty spells out allocations for both the Yarmuk and Jordan Rivers, as well as regarding Arava/Araba groundwater, and calls for joint efforts to prevent water pollution. Also, “[recognizing] that their water resources are not sufficient to meet their needs,” the treaty calls for ways of alleviating the water shortage through cooperative projects, both regional and international.

According to Annex II of the accord:

- Israel will limit its withdrawals from the Yarmuk to 25 MCM per year. Jordan has rights to the rest of the normal flow of the river plus 10 MCM per year of desalinated brackish spring water (out of a total of 20 MCM per year to be desalinated).

- Jordan will effectively store 20 MCM per year of winter floodwater in Israel by allowing Israel to pump it from the Yarmuk in the winter and having it returned from the Jordan in the summer. Floodwater in addition to current uses will be split between the two countries.

- Two dams will be constructed—one each on the Yarmuk and the Jordan (Israel can use up to 3 MCM per year of increased storage capacity).

- Israel can expand by 10 MCM per year pumping of groundwater wells in the Arava/Araba area, which according to the redefined border now falls within Jordanian territory.

- An additional 50 MCM per year will be developed through joint projects to be determined by a Joint Water Committee.

- The Joint Water Committee, comprised of three members from each country, will also collect relevant data on water resources, specify work procedures and details, and form specialized subcommittees, as needed.

Although the pace of the peace talks has been at times arduously slow, a venue does finally exist where grievances can be aired and the issue of water-sharing equity can be tackled. This, in itself, may help prevent pressures that historically have led to some of the most bitter water conflicts in the world.

Before determining whether the future will take the shape of increasing riparian disputes and perhaps armed hostilities or, alternatively, of greater cooperation and regionwide planning, some observations are in order about the crux of most water conflicts—equity in allocating water resources.

Measuring Equity in Water Resource Disputes

At the heart of water conflict management is the question of "equity."[10] Criteria for equity, a vague and relative term in any event, are particularly difficult to determine in water conflicts, where international water law is ambiguous and often contradictory, and no mechanism exists to enforce agreed-upon principles. However, application of an equitable water-sharing agreement along the volatile waterways of the Middle East is a prerequisite to hydropolitical stability, which finally could help propel political forces away from conflict in favor of cooperation. This section describes some existing measures of water-sharing equity, their strengths, and their weaknesses in the context of Middle East hydropolitics.

International Water Law

According to Cano (1989), international water law did not substantially begin to be formulated until after World War I. Since that time, organs of international law have tried to provide a framework for increasingly intensive water use. The concept of a "drainage basin," for example, was accepted by the International Law Association in the Helsinki Rules of 1966, which also provides guidelines for "reasonable and equitable" sharing of a common waterway (Caponera 1985). Article IV of the Helsinki Rules describes the overriding principle:

> Each basin State is entitled, within its territory, to a reasonable and equitable share in the beneficial uses of the waters of an international drainage basin.

Article V lists no fewer than 11 factors that must be taken into account in defining what is "reasonable and equitable."[11] There is no hierarchy to these components of "reasonable use"; rather they are to be considered as a whole. One important shift in legal thinking in the Helsinki Rules is that they address the

[10] Some of the following discussion is drawn from Wolf and Dinar 1994.

[11] The factors include a basin's geography, hydrology, climate, past and existing water utilization, economic and social needs of the

right to "beneficial use" of water, rather than to water per se (Housen-Couriel 1992, 5).

The International Law Commission, a U.N. body, was directed by the General Assembly in 1970 to study "Codification of the Law on Water Courses for Purposes Other than Navigation." The general principles being codified include (Caponera 1985)

1. Common water resources are to be shared equitably between the states entitled to use them, with related corollaries of
   - limited sovereignty,
   - duty to cooperate in development, and
   - protection of common resources.
2. States are responsible for substantial transboundary injury originating in their respective territories.

The problems arise when attempts are made to apply this reasonable but vague language to specific water conflicts. In the Middle East, for example, riparian positions and consequent legal rights shift with changing borders, many of which are still not recognized by the world community. Furthermore, international law only concerns itself with the rights and responsibilities of states. Some political entities who might claim water rights, therefore, would not be represented, such as the Palestinians along the Jordan or the Kurds along the Euphrates.

International law seeks to develop general principles that can then be applied to specific problems. It is testimony to the difficulty of marrying legal and hydrologic intricacies that the International Law Commission, despite an additional call for codification at the U.N. Water Conference at Mar de Plata in 1977, has not yet completed its task. After 20 years and nine reports, only several articles have been provisionally approved. Once the details are worked through, the principles would not have the force of law until approved by the U.N. General Assembly (Solanes 1987). Even then, cases are heard by the International Court of Justice only with the consent of the parties involved, and no practical enforcement mechanism exists to back up the Court's findings, except in the most extreme cases. A state with pressing national interests can therefore disclaim entirely the court's jurisdiction or findings (Caponera 1985; Cano 1989).

Needs-Based Equity

Many of the common claims for water rights are based either on geography, that is, from where a river or aquifer originates and how much of that territory falls within a certain state, or on chronology, who has been using the water the longest. Their extreme positions have been referred to as "the doctrine of absolute sovereignty," meaning that a state has absolute rights to water flowing through its territory, and "prior appropriation," that is, "first in time, first in right" (Roger 1991).

These conflicting doctrines of geography and chronology clash along all of the rivers of the Middle East, with positions usually defined by riparian positions. Downstream riparians, such as Iraq and Egypt, often receive less rainfall than their upstream neighbors and therefore have depended on river water for much longer. As a consequence, modern rights-based disputes often take the form of upstream riparians such as Ethiopia and Turkey arguing for the doctrine of absolute sovereignty, with downstream riparians taking the position of prior appropriation.[12]

In many of the Middle East water disputes that have been resolved, however, the paradigms used for negotiations have not been rights-based, either on geography or chronology, but rather needs-based. In agreements between Egypt and Sudan signed in 1929 and in 1959, for example, allocations were based on local needs, primarily of agriculture. Egypt argued for a greater share of the Nile because of its larger population and extensive irrigation works. Current allocations of 55.5 BCM per year for Egypt and 18.5 BCM per year for Sudan reflect these needs.[13]

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riparians, population, comparative costs of alternative sources, availability of other sources, avoidance of waste, practicability of compensation as a means of adjusting conflicts, and the degree to which a state's needs may be satisfied without causing substantial injury to a co-basin state.

[12]For examples of these respective positions, see the exchange about the Nile between Jovanovic 1985, 1986 and Shahin 1986 in *Water International* and the description of political claims along the Euphrates in Kolars and Mitchell 1991.

[13]For descriptions of negotiations between Egypt and Sudan in 1929 and 1959, see Naff and Matson 1984 and Krishna 1988.

Likewise, along the Jordan River, the only water agreement ever negotiated (although not ratified), the Johnston Plan, emphasized the needs rather than the inherent rights of the riparians. Johnston's approach, based on a report prepared for the TVA, was to estimate, without regard to political boundaries, the water needs for all irrigable land within the Jordan Valley basin that could be irrigated by gravity flow (Main 1953). National allocations were then based on these in-basin agricultural needs, with the understanding that each country could use the water as it wished, including diverting it out-of-basin. This was not only an acceptable formula to the parties, but it allowed for a breakthrough in negotiations when a land survey of Jordan concluded that its future water needs were lower than previously thought.

Because of its relative success, needs-based allocation has been advocated for the region in recent disputes as well, notably in and around the Jordan River watershed where riparian disputes exist not only along the river itself, but also over several shared groundwater aquifers. Shuval (1992), for example, argues for a minimum baseline allocation between Israel, West Bank Palestinians, and Jordan, based on a per capita allotment of 100 cubic meters per year for domestic and industrial use plus 25 cubic meters per year for agriculture. Adding 65 percent of urban uses for recycled wastewater, Shuval arrives at a hypothetical 2022 allocation as 950 MCM per year for Palestinians, 1,330 MCM per year for Jordan, and 1,900 MCM per year for Israel. Since the regional freshwater supply is only about 2,500 MCM per year, Shuval also advocates a series of water import schemes and desalination plants to provide the difference between regional supply and future demand.

Wolf (1993) likewise advocates a needs-based approach, but considers new sources such as recycled wastewater separate issues. By planning for total urban needs of 100 cubic meters per year per person, and extrapolating to the point in the future where all of the basin's 2,500 MCM per year has to be allocated first to these needs—in other words, when the regional population reaches 25 million, expected early in the next century—Wolf arrives at annual allocations of 1,000 MCM per year for Israel, 1,000 MCM per year for Jordan, 300 MCM for the Palestinians on the West Bank, and 200 MCM for those in Gaza.

Although needs-based negotiations have been more successful in practice in the Middle East than rights-based claims, this is not to say agreement has been absolute. As noted above, agreement along the Nile has included only two of the nine riparian states, Egypt and Sudan, both minor contributors to the river's flow. No other state riparian to the Nile has ever exercised a legal claim to the water allocated in the 1959 treaty (Whittington and McClelland 1992, 145). The notable exception to the treaty, and the country that might argue most adamantly for greater sovereignty, is Ethiopia, which contributes 75 to 85 percent of the Nile's flow. Political complexities have likewise hindered ratification of water-sharing agreements along both the Jordan and the Euphrates Rivers, with upstream versus first-user arguments still prevalent. Success has often depended on how well the negotiating strategy coincided with the political complexities of the region.

Economic Equity

One lately emerging principle incorporated into water conflict resolution is the allocation of water resources according to their economic value. Here we distinguish between efficiency—the reallocation of water to its highest value use—and equity—the psychological satisfaction of a fair allocation. The idea is that different uses and users of the water along a given waterway may value the resource differently. Therefore, equitable water-sharing should take into consideration the possibility of increasing the overall efficiency of water utilization by reallocating the water according to these values. This principle alone may not be accepted as equitable by the parties involved. However, inclusion of economic aspects in water resource allocation may enhance cooperation and future collaboration.

Central planning versus market approaches. Allocation according to the economic value of water has usually been demonstrated using two approaches. The long-standing approach assumes a central planning authority who knows what is best for society—a social planner who views the region as one planning unit. The social planner maximizes regional welfare subject to all available water resources in the region and given all possible water-utilizing sectors. In some instances the social planner (government) also includes preferences (policy). A second approach is the water market approach, which employs the market mechanism to achieve an efficient allocation of scarce water resources among competing users.

Examples of these approaches can be found in several studies that consider institutional and economic aspects of international cooperation for interbasin development. Goslin (1977) examined the economic, legal, and technological aspects of the Colorado River basin allocation between the U.S. riparian states and Mexico. Krutilla (1969) analyzed the economics of the Columbia River Agreement between the United States and Canada. LeMarquand (1976) developed a framework to analyze economic and political aspects of water basin development. And Haynes and Whittington (1981) suggested a social planner solution for the entire Nile basin.

Recent studies[14] have questioned the equity and justice associated with market allocations. These studies conclude that economic considerations alone may not provide an acceptable solution to water allocation problems, especially allocation disputes between nations. While the social planner and the market approaches may provide solutions to regional water allocation, they suffer several drawbacks that may affect the efficiency and the acceptability of the proposed solution. The social planner approach assumes that all social preferences are known and incorporated into the regional objective function. This of course might not be the case, especially when dealing with regional water allocations that involve many countries with cultural differences and preferences.

The market approach assumes the existence of many parties in the region, each acting independently, so that the market price for water reflects its true value for each party. If, in that market, one party's decision does not affect the outcome for other individuals, then the self-interest of the parties leads to an efficient outcome for the whole region. In the case of water, one party's decision may affect another party's outcome, creating what is called an externality, or third-party effect. If the externality effect (cost) is not included in the supply curve of water, the market mechanism collapses. This introduces inefficiency into the system and results in what economists call market failure. In the case of water (in a water basin), the externality effects might be multidirectional. This is particularly true for water basins shared by more than one country, and for water used for more than one purpose. Also, water allocation problems are not exactly similar to familiar market setups (for example, the market for cars), because they are characterized by a relatively small number of agents with different objectives and perspectives.

Game theory. Game theory is an approach that allows the incorporation of economic and political aspects into a regional water-sharing analysis with a small number of participants, each with different objectives and perspectives. The principles of game theory are not discussed here in detail, but can be found elsewhere.[15]

For the game theorist, the dichotomy of whether two riparian states or political entities work unilaterally in pursuit of only their own goals or cooperatively in pursuit of regional goals is recognizable as a familiar two-player, two-strategy game. In the language of the theory, unilateral water resources development might be referred to as a "defection" strategy, while working together is referred to as a "cooperation" strategy. Each player chooses a strategy depending on such factors as regional geopolitical relations, relative levels of economic development, and riparian position.

For two water basins within the same political entity, with clear water rights and a strong government interest, the game may resemble what is known as a "stag hunt," where mutual cooperation is the rational strategy. Between somewhat hostile players, either within a state or more often internationally, the game becomes a "prisoner's dilemma," where, in the absence of strong incentives to cooperate, each player's individual self-interest suggests defection as the rational approach. One example of this might be the Nile basin. In cases of high levels of hostility, a game of "chicken" can develop, with players competing to divert or degrade the greatest amount of water. The southernmost part of the Jordan River might be used as an example of riparians playing a game of "chicken," with Syrian, Jordanian, and Israeli unilateral diversions all impeding basin-wide cooperation.

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[14]See, for example, Margat 1989; London and Miley, Jr. 1990; Yaakov and Easter 1994; and Frohlich and Oppenheimer 1994.
[15]See, for example, Shubik 1984.

To cooperatively solve the problem of water allocations within the water basin, the parties involved should realize some mutual benefit that can be achieved only through cooperation. In cases of cooperation, each party needs to voluntarily participate, and accept the joint outcome from the cooperative project. Once a cooperative interest exists, the only problem to be solved is the allocation of the associated joint costs or benefits. For a cooperative solution to be accepted by all parties, it is required that (1) the joint cost or benefit is partitioned such that each participant is better off compared with a noncooperative outcome, (2) the partitioned cost or benefit to participants is preferred in the cooperative solution compared with subcoalitions that include part of the potential participants, and (3) all the cost or benefit is allocated.

The economic literature dealing with application of game theory solutions does not provide many examples of regional-international water-sharing problems. Rogers (1969) applied a game theory approach to the disputed Ganges-Brahmaputra subbasin that involves different uses of the water by India and Pakistan. The results suggest a range of strategies for cooperation between the two riparian nations that will result in significant benefits to each. In a recent paper, Rogers (1991) further discusses cooperative game theory approaches applied to water-sharing in the Columbia basin between the United States and Canada; the Ganges-Brahmaputra basin among Nepal, India, and Bangladesh; and the Nile basin between Ethiopia, Sudan, and Egypt. In-depth analysis is conducted for the Ganges-Brahmaputra case where a joint solution in which each country's welfare is better off is compared with any noncooperative solution (Rogers 1993).

Dinar and Wolf (1994), using a game theory approach, evaluate the idea of trading hydrotechnology for interbasin water transfers among neighboring nations. They attempt to develop a broader, more realistic approach that addresses both the economic and political problems of the process. A conceptual framework for efficient allocation of water and hydrotechnology between two potential cooperators provides the basis for trade of water against water-saving technology. A game-theory model is then applied to a potential water trade in the western Middle East, involving Egypt, Israel, the West Bank, and the Gaza Strip. The model allocates potential benefits from trade between the cooperators. Main findings are that economic merits exist for water transfer in the region, but political considerations may harm, if not block, the process. Part of the objection to regional water transfer might be due to unbalanced allocations of the regional gains, and part is due to other regional considerations.

The major barrier to water's role as an agent of peaceful relations is the lack of a widely accepted measure for equitably dividing shared water resources. Many disciplines offer tentative or partial guidelines, including legal, needs-based, and economic equity. Each measure alone, however, cannot incorporate all of the physical, political, and economic characteristics unique to each of the world's international waterways. To supplement this approach, the following section offers a process for cooperative watershed development, based on the guidelines of dispute systems design.

Cooperative Watershed Development

Just as there are difficulties inherent in water resource conflicts brought on by the qualities particular to the resource, so too does water resource planning and development offer specific aspects that can encourage cooperation between riparians. And, given the vital need for a regional water development plan that incorporates the political realities of the region as well as the limitations imposed by economics and hydrology, possible steps that might be taken are described below.

A recently developed subfield of Alternative Dispute Resolution (ADR), dispute systems design is a process of integrating the potential for ADR into public institutions and other organizations that deal with conflict. Described by Ury, Brett, and Goldberg (1988), dispute systems design may offer lessons about enhancing cooperation in water systems as well. Although most of the work in this field describes the incorporation of cooperation-inducement into organizations, some of the same lessons for "enhancing cooperation capacity" (Kolb and Silbey 1990), or "design considerations" (O'Connor 1992), or "design guidelines" (McKinney 1992), might be applicable to technical or policy systems as well. A water-sharing agreement, or even a regional water development project, for example, might be designed from the beginning specifically to induce ever-increasing cooperation, as the project incorporates ever-increasing integration.

The preceding survey of history suggests that cooperation-inducing strategies might be incorporated into the process of implementation as well. This section offers examples of cooperation-inducing implementation. General guidelines include the following:

1. Disintegrating the control of water resources to address past and present grievances. Many plans for water development in the Jordan River watershed incorporate the premise that increased integration of institutions or water projects encourages greater political stability.[16] While the advisability of striving toward ever-increasing integration is recognized, as is the fact that "lasting peace among nations is characterized by a broadly based network of relations," in the words of Ben-Shahar (1989,1), it is nevertheless suggested that, for resource conflicts in general and for water conflicts in particular, it should first be ensured that each entity has adequate control of an equitable portion of its primary resource. Past and present grievances need to be addressed before embarking on projects of cooperation or integration.

   Because much of the past conflict over water has concerned ambiguous water rights, any attempt at cooperative projects preceding the clarification of these rights would be building on years of accumulated ill will. The clear establishment of property rights is also a prerequisite for any market solutions, such as water banks or markets, that might be applied. Furthermore, as mentioned previously, the political viability of international planning or projects depends on each entity agreeing on the equity of the project (who gets how much) and on control of the resource (who exercises control, and from where). The necessary steps include

   - negotiating property rights to existing resources,
   - guaranteeing control of a water source adequate to meet future needs, and
   - addressing the issue of equity within the design of any cooperative project.

   Since these steps involve a separation of control as a precondition to integration, this process might be referred to as disintegration.

2. Examining the details of initial positions for options to induce cooperation. Each party to negotiations usually has its own interests foremost in mind. The initial claims, or "starting points" in the language of ADR, often seek to maximize those interests. By closely examining the assumptions and beliefs behind the starting points, one might be able to glean clues about how to induce some movement within the bargaining mix, or range within which bargaining can take place, for each party. These underlying assumptions and beliefs may also indicate the creative solutions needed to move from distributive bargaining (win-lose) over the amount of water each entity should receive to integrative bargaining (win-win), that is, inventing options for mutual gain.

3. Designing a plan or project, starting with small-scale implicit cooperation and building toward ever-increasing integration, always helping to facilitate political relations. Building on the first two steps, riparians of a watershed who have clear water rights and control of enough water for their immediate needs might begin to work slowly toward increasing cooperation on projects or planning. Even hostile riparians, it has been shown, can cooperate if the scale is small and the cooperation is secret. Building on that small-scale cooperation, and mindful of the concerns of equity and control, projects might be developed to increase integration within the watershed, or even between watersheds over time.

[16] See, for example, the proposals of Kally 1989a. As noted earlier, Kally contends that "the successful implementation of cooperative projects . . . will strengthen and stabilize peace" (p. 325). This concept of inducing increasing integration even between actors with hostility toward each other is also a strategy employed in the United States by the U.S. Army Corps of Engineers and recommended for international settings by Corps representatives.

Along with these three principles, a viable agreement should also incorporate mechanisms for resolving any future misunderstandings. The circumstances that bring about a conflict are seldom static, and neither are the conditions of agreement. This is particularly true for hydrologic conflicts, where supply, demand, and understanding of existing conditions all change from season to season and from year to year. Finally, crisis management for droughts, floods, and technical (for example, dam or sewage facility) failures must also be addressed.

The design of a plan or project can incorporate a feedback loop to allow for greater cooperation as political relations develop, encouraging the project to remain on the cutting edge. A process for ongoing conflict resolution would also help relieve tensions that might arise due to fluctuations in the natural system. This process of cooperation-inducing design can be applied to water rights negotiations, to watershed planning, or to cooperative projects for watershed development.

The cooperation-inducing design process described here—moving from small and doable projects to ever-increasing cooperation and integration and remaining on the cutting edge of political relations—has been applied to water rights negotiations, as is currently the case between Palestinians and Israelis; to watershed planning, such as the incremental steps leading to the Israel-Jordan Peace Treaty; and to cooperative projects for watershed development, such as the Middle East multilateral working group on water.

Ironically, many of the same aspects of water resources that make them conducive to conflict also allow their management to induce cooperation. These characteristics include

- Physical parameters. The fluctuations inherent in the hydrologic cycle result in countries having surpluses and shortages at different times, allowing options for trade.
- “Wheeling.” Water resources, like energy resources, can be traded stepwise over great distances. Any addition to the water budget in the Jordan watershed, for example, can be “wheeled” anywhere else. Litani or Turkish water diverted into the Jordan headwaters in Israel can be credited for Yarmuk water to Jordan, which in turn might allow more water in the lower Jordan for the West Bank, which might result in surplus West Bank groundwater being diverted to Gaza, and so on. This cost-saving practice of “wheeling” can only be achieved, however, when infrastructure is designed from the beginning for future cooperation.
- Structural considerations. Not only can water resources infrastructure be designed for future cooperation, but topographic and hydrographic differences between countries can also be taken advantage of for trade between countries. Upstream riparians like Turkey and Ethiopia might have better access to good dam sites, for example, which might be developed cooperatively with downstream riparians. The Sea of Galilee has likewise been suggested as a storage facility for the Jordan riparians in absence of a Unity Dam.
- Economic factors. Water is worth different things to different people, allowing incentives for trade once property rights to the resource have been established.
- Training of water managers. Perhaps more than managers of any other resource, water managers think regionally, beyond their borders, by training and practice. It is not surprising, therefore, that water managers have been able to reach agreements often well in advance of their political counterparts.
- Water science. Countries within a watershed develop different levels of water technology, often with different emphases. While Israel has emphasized drip irrigation and genetic engineering, Gulf states have invested heavily in desalination. Trade of existing technologies and joint research and development projects provide ideal venues to enhance regional cooperation.

Many aspects particular to water resources can both provoke conflict and induce cooperation. The water conflicts presented here suggest that, with early planning, one can help guide riparians along the latter path. To do so, however, takes foresight and awareness of the options throughout the negotiating process.

Conclusions and Observations

Given the years that the Middle East has been enmeshed in bitter conflict, the pace of the peace process has been impressive, and no less so in the area of water resources. This may be due in part to the structure of the peace talks, with the two complementary and mutually reinforcing tracks—bilateral and multilateral. As noted earlier, past attempts at resolving water issues separately from their political framework, from the early 1950s through 1991, have all failed. It has been clear that regional water issues could not be solved in advance of high political issues. Yet the pace of the talks also argues that high and low political issues may best be dealt with simultaneously—that, just as there could be no water-sharing agreements without peace, there may not be real peace without water-sharing agreements.

Despite the relative success of the multilateral working group on water and its stated objective to deal with nonpolitical issues of mutual concern, one might wonder where the process goes from here. The working group on water has performed admirably in the crucial early stages of negotiations as a vehicle for venting past grievances, presenting various views of the future, and, perhaps most important, allowing for personal "de-demonization" and confidence-building on which the future peace of the region will be built. Currently, however, many of the participants in the working group are frustrated that it is not, by design, a vehicle for actually resolving conflicts. The contentious topics of water rights and allocations, which some argue must be solved before proceeding with any cooperative projects, are relegated to the bilateral negotiations, where they take a lower priority. Likewise, the principles of integrated watershed management are difficult to encourage: water quantity, quality, and rights all fall within the purview of different negotiating frameworks—the working group on water, the working group on the environment, and the various bilateral negotiations, respectively. Finally, and perhaps somewhat related, there are the limitations imposed by who does and does not take part. Syria and Lebanon have not agreed to participate in any of the multilateral working groups. This omission means that a comprehensive settlement of the conflicts related to the Jordan or Yarmuk Rivers is precluded from discussions. Also, the focus of these talks has been the core region, including Israel and its neighbors, and has yet to include most of the Nile riparians or Iraq.

The history of hydropolitics along the rivers of the Middle East exemplifies both the worst and the best of relations over international water. While shared water resources have led to, and occasionally crossed, the brink of armed conflict, they have also been a catalyst to cooperation between otherwise hostile neighbors, albeit rarely and secretively.

With the flow of water ignoring political boundaries, and with appropriate measures of water equity eluding disciplinary boundaries, the history of hydropolitics in the Middle East gives one a glimpse into a gloomy but probable future for many of the more than 200 international river basins. Without agreed-upon criteria for fair ownership and distribution of such a vital resource, many may come to experience the sentiments of Byron:

> Till taught by pain, men know not water's worth.

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